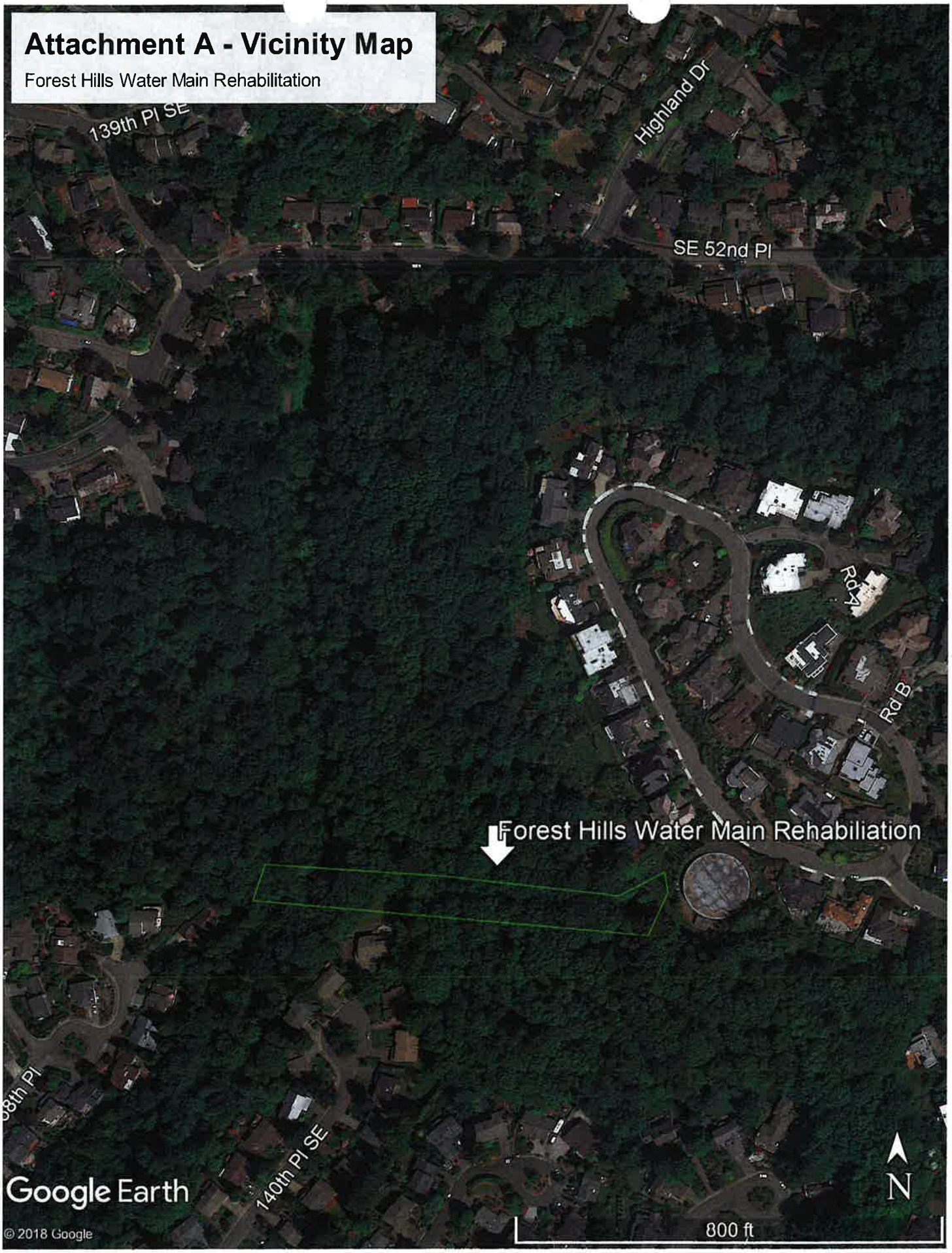
Attachment A - Vicinity Map
Forest Hills Water Main Rehabilitation
139th Pl SE
Highland Dr
SE 52nd Pl
Rd A
Rd B
Forest Hills Water Main Rehabiliation
140th Pl SE
Google Earth
© 2018 Google
N
800 ft

Stantec

Memo

To:	Reilly Pittman, City of Bellevue Senior Planner, Development Services Department	From:	Kristi Rettmann, Environmental Scientist Stantec
File:	Critical Areas Narrative for the Forest Hills Water Main Rehabilitation Project City of Bellevue Utilities Department	Date:	March 22, 2019

Reference: Critical Areas Land Use Permit Application for the Forest Hills Water Main Rehabilitation Project

PROJECT DESCRIPTION

The City of Bellevue (City) Utilities Department plans to replace the existing buried 12-inch ductile iron (DI) water main (approximately 700 linear feet [LF]) between the City's Forest Hills Reservoir and the existing pressure reducing valve (PRV) station #100959, within the Forest Park Open Space (owned by the Bellevue Utilities Department). An approximate overview of the Forest Park Open Space showing the project area is included as Attachment A. Recent testing reveals that the existing DI water main is failing prematurely, due to corrosion, with an expected remaining service life of only one to two years. To prevent the potential for a catastrophic break, replacement of this pipe has been added to the Capital Improvement Project for replacement in calendar year 2019. The locations of the existing and proposed water mains are shown in Figure 2.

Approximately 700 LF of replacement pipe will be installed using open cut trench excavation methods, except for where it crosses under the unnamed ephemeral creek. To avoid disturbing the creek, jack and auger bore or pipe ramming will be used to bore the replacement water main under the creek (6 feet below the creek bed), within a new permanent steel casing. The sending and receiving bore pits will be located within the stream buffer close to the stream. The 12-inch diameter restrained joint C900 PVC water main will be installed south of, and parallel to, the existing water main. Within tax parcel 2600110290, the pipe will cross under the existing water main and will be installed north of, and parallel to, the existing water main. PRV station 100959 will be abandoned in place, and a new PRV station and 263 LF of connecting pipe will be installed within the ROW and public easements in the cul-de-sac at the north end of 140th Pl SE.

EXISTING CONDITIONS AND CRITICAL AREAS WITHIN THE PROJECT

Most of the project is located in the Forest Park Open Space, tax parcel #2597450870, situated South of Highland Drive and West of 142nd Ave SE. The proposed water main alignment runs from the reservoir tank located on tax parcel 2224059034, off of 142nd Ave SE, and extends westward down a steep forested slope varying from about 20 to 70 percent and crosses under the northernmost area of 5600 140th Pl SE to the bottom of the hill. Within this heavily forested open space, there is also a dirt foot path that switchbacks down the slope. The site is centered in a residential neighborhood consisting of single-family homes on primarily 1/4-acre to 1/3-acre lots. An ephemeral stream runs through the western edge of the site, running north to south, paralleling a utility access road to the west. A steep slope starting near the eastern stream bank rises sharply up to 142nd Ave SE. A moderately steep slope starting near the western stream bank rises up to the existing PRV 100959 where an existing maintenance access runs north to Highland drive. This access has not been maintained in a few years and has mostly deciduous trees along each side of the access.

During a site visit by Stantec biologists on March 1, 2019, it was noted that the overstory within entire open space area consists of approximately 80% deciduous (big-leaf maple, red alder, cottonwood, black poplar) and 20% coniferous trees (Western red cedar, Douglas fir), many of which were greater than 12" in diameter.

Vegetation down the length of the steep slope from the reservoir to eastern stream buffer includes, but is not limited to sword ferns, low Oregon grape, tall Oregon grape, and salal. Vegetation within the ephemeral stream buffer include but are not limited to Indian plum, salmonberry, buttercup, horsetail, and Herb Robert. Invasive vegetation noted were Himalayan blackberry was observed farther north up the stream, and English ivy covering most of the open space on tax parcel 2224059034, where the reservoir is located.

During the site visit on March 1, 2019, the following critical areas, as defined in LUC20.25H.025, were identified during the site visit: an unnamed, ephemeral stream and a geologic hazard area (steep slopes). These features are discussed below.

Stream

During the March 2019 site visit, the stream was running and appeared to be fed by through groundwater seeps at the northern end of the open space area, as well as by stormwater runoff from two storm drain culverts running from the stormwater retention ponds at the north end of the area. The ephemeral unnamed stream is classified as Type Np (non-fish bearing) by the City due to its ephemeral (dry during the summer to early fall months) status, as defined in LUC 20.25H.075. The ordinary high-water mark (OHWM) of the stream, in relation to the proposed project alignment, was determined based on the definition provided by WAC 173-22-030. OHWM is located by examining the bed and bank physical characteristics and vegetation to determine the water elevation for mean annual floods. Stantec biologists made note of OHWM along the stream primarily based on accumulated leaf and debris, as well as by the transition between the upland vegetation (taller shrubs, trees, and ferns) and shoreline vegetation along the stream banks.

Steep Slopes

Desktop review of the City's online hazard area maps and LUC 20.25H.120 show that the project area contains both steeps slopes, and the entire area open space is identified as being a very severe soil erosion hazard. This critical area designation is confirmed in Shannon and Wilson's Draft Geotechnical Report and in Figure 3 of their report (2019). No sloughing or surface instability of the steep slope areas were noted during the March 1, 2019 site visit. Additionally, Shannon and Wilson did not observe any surface instability, but suggested that shallow, surficial sliding or accelerated creep associated with weathering of the underlying bedrock could potentially occur in wet conditions.

ALTERNATIVE PROJECT ALIGNMENTS AND COMPONENTS CONSIDERED

The following are rationale of why there is no feasible alternative with less impact to the critical areas or critical area buffer:

- The project cannot be relocated out of the critical areas (steep slopes or ephemeral creek) due to the location of existing utilities that it must connect to, as well as topographic conditions that are present.
- A previous alignment was considered that would involve crossing the creek farther north of the current proposed crossing and meandering through the forested slope, meeting up with a straight line up the eastern steep slope to the reservoir. This alternative was not selected because it would have required removing larger trees, increase the number of trees removed, and would require deeper bore pits.

Reference: **Critical Areas Land Use Permit Application for the Forest Hills Water Main Rehabilitation Project**

- Location of the bore pits father away from the stream and stream buffer was not feasible as the bore pits would have to be deeper and more trees would need to be removed. The location of the existing water main prevents moving the bore pit further west.
- Traditional open-cut trenching through the ephemeral creek during the dry months was considered as it would be the fastest way across the stream with the least impact to stream buffers. However, this option was not selected due to the lengthy permitting review process involving Federal permits.
- Boring under the slope using horizontal directional drilling (HDD) was initially considered as an idea to completely avoid the stream, stream buffer, and steep slopes, and allow the new line to meet up with existing utilities right where they are with minimal ground disturbance. However, the extreme steep slopes and the depth of the ravine made it unfeasible to use the larger drilling equipment required to obtain the necessary deeper geotechnical borings to fully evaluate the feasibility of using HDD at this location. Additionally, the extreme arc that the pipe would have to curve up on such a steep slope to reach the existing utility tie-in at the reservoir would result in a very deep pipe installation that could not be accessed in the future.

The currently proposed project alignment was selected because it minimizes removal of trees (especially significant trees), minimizes root disturbance of trees left in place, avoids impact to the ephemeral stream by going under it, and is the most direct route to the location of existing utilities to which it must connect. The work will be conducted during the dry summer months and will utilize a lighter pipe material, both of which minimize erosion potential on the steep slopes. The lighter pipe material (PVC) allows greater mobility of equipment and personnel on a steep slope.

LAND USE CODE PERFORMANCE STANDARDS APPLICABLE TO THE PROJECT

As noted by the City in responses to questions during the predevelopment meeting, this utility rehabilitation project is an allowed use under LUC 20.25H.055 and does not require a critical areas report. With the exception of 19 trees to be removed within the project alignment, all remaining impacts to critical areas will be temporary with the areas of disturbance restored back to their original or better condition. Although repair and maintenance utility work is an allowed us within critical areas and critical area buffers (per 20.25H.055C.1, table in subsection B), the ways in which the proposal meets each of the applicable land use performance standards, associated with ephemeral streams and steep slopes, were still evaluated below. (Land use code is in *blue* and responses in black.)

20.25H.055 C.1. Uses and development allowed within critical areas – Performance standards.

C. Performance Standards.

The following performance standards apply as noted in the table in subsection B of this section. The critical areas report may not be used to modify the performance standards set forth in this subsection C:

1. Repair and Maintenance and/or Construction Staging.

The project meets this performance standard. The proposed project will be to construct a replacement (install) 12" public water main (due to corrosive breakdown of existing pipe) as near to the existing water main alignment as possible. The replacement and associated construction staging are allowed uses within the stream buffer and along the steep slope of the site.

Reference: Critical Areas Land Use Permit Application for the Forest Hills Water Main Rehabilitation Project

a. Work shall be consistent with all applicable City of Bellevue codes and standards;

The proposed project will meet all applicable City of Bellevue codes and standards for a utility maintenance project, including obtaining all required permits and providing all supporting documentation, when requested by the City, for these permits.

b. Removal of significant trees is prohibited; and

The project does not meet this performance criteria due the project alignment requiring that 19 trees be removed (15 of which are significant trees, 8 inches or greater in diameter). However, replacement significant trees will be replanted using conifers (Western red cedar and Douglas fir) at a 3:1 ratio. Trees will be planted away from the new pipe alignment in open areas where appropriate to avoid roots growing into the proposed pipe alignment area.

c. Areas of temporary disturbance associated with the work shall be restored to pre-project conditions, pursuant to a restoration plan meeting the requirements of LUC 20.25H.210.

The project meets this performance standard. The majority of disturbance in critical areas (stream buffer and steep slopes) will be temporary with the areas of disturbance restored back to their original or better condition and planted with native vegetation as described in the Restoration and Planting Plan (Attachment B). Additionally, trees flagged for removal will be cut at their base leaving the roots. Grubbing of roots will only be necessary to actually trench and backfill the water main. Root wads will be left intact to the maximum extent feasible to maintain stability of slope soils. Mitigation trees will be planted in accordance with the arborist recommendations.

2. New and Expanded Uses or Development. As used in this section, "facilities and systems" is a general term that encompasses all structures and improvements associated with the allowed uses and development described in the table in subsection B of this section:

a. New or expanded facilities and systems are allowed within the critical area or critical area buffer only where no technically feasible alternative with less impact on the critical area or critical area buffer exists. A determination of technically feasible alternatives will consider:

i. The location of existing infrastructure;

The project meets this performance standard. It is imperative that the old water main remain in service while the new line is being installed. To reduce the number of trees to be removed, the new water main alignment is as close to the old alignment as possible and follows a path that avoids as much removal of larger significant trees as possible. This waterline must connect the reservoir to the existing water distribution main downslope; therefore, it must be located within the steep slope and cross under the creek.

ii. The function or objective of the proposed new or expanded facility or system;

The project meets this performance standard. The project will perform the same function of the existing water main but will endure for decades to come due to the selected pipe material (PVC). This project is replacing a failing water main that is essential to water service for the surrounding area.

Reference: Critical Areas Land Use Permit Application for the Forest Hills Water Main Rehabilitation Project

iii. Demonstration that no alternative location or configuration outside of the critical area or critical area buffer achieves the stated function or objective, including construction of new or expanded facilities or systems outside of the critical area;

The project meets this performance standard. The water main must connect to the reservoir to the existing water distribution system. Consequently, there can be no other location than the steep slope and crossing under the creek. It is imperative that the old water main remain in service while the new line is being installed. To reduce the number of trees to be removed, the new water main alignment is as close to the old alignment as possible and follows a path that avoids as much removal of larger significant trees as possible.

iv. Whether the cost of avoiding disturbance is substantially disproportionate as compared to the environmental impact of proposed disturbance; and

The project meets this performance standard. While cost is an important consideration, for this project, it is not a cost issue. This is a replacement for an existing (already located within critical areas), failing water main. There is no other technically feasible location for this replacement water main.

v. The ability of both permanent and temporary disturbance to be mitigated.

The project meets this performance standard. See Restoration and Planting Plan described herein and in Attachment B. This is a buried facility, that once constructed, will not impact functions and values of the critical areas.

b. i. Location and design shall result in the least impacts on the critical area or critical area buffer;

The project meets this performance standard. The currently proposed project alignment was selected because it allowed for the minimal removal of trees (especially significant trees), minimizes root disturbance of trees left in place, avoids impact to the ephemeral stream by going under it, and is the most direct route to the location of existing utilities to which it must connect. The work will be conducted during the dry summer months and will utilize a lighter pipe material, both of which minimize erosion potential on the steep slopes. The lighter pipe material (PVC) allows greater mobility of equipment and personnel on a steep slope.

ii. Disturbance of the critical area and critical area buffer, including disturbance of vegetation and soils, shall be minimized;

The project meets this performance standard. The design of the project allows for minimal removal of trees (especially significant trees), minimizes root disturbance of trees left in place, avoids impact to the ephemeral stream by going under it, and is the most direct route to the location of existing utilities to which it must connect. The work will be conducted during the dry summer months and will utilize a lighter pipe material, both of which minimize erosion potential on the steep slopes.

iii. Disturbance shall not occur in habitat used for salmonid rearing or spawning or by any species of local importance unless no other technically feasible location exists;

The project meets this performance standard. The ephemeral unnamed stream the stream is classified as Type Np (non-fish bearing) by the City due to its ephemeral (dry during the summer to early fall months) status, as defined in LUC 20.25H.075.

Reference: **Critical Areas Land Use Permit Application for the Forest Hills Water Main Rehabilitation Project**

iv. Any crossing over a wetland or stream shall be designed to minimize critical area and critical area buffer coverage and critical area and critical area buffer disturbance, for example by use of bridge, boring, or open cut and perpendicular crossings, and shall be the minimum width necessary to accommodate the intended function or objective; provided, that the Director may require that the facility be designed to accommodate additional facilities where the likelihood of additional facilities exists, and one consolidated corridor would result in fewer impacts to the critical area or critical area buffer than multiple intrusions into the critical area or critical area buffer;

The project meets this performance standard. Rather than crossing through open cut methods, the proposed project will avoid the creek altogether going under the creek. Installation under the creek will be through a jack and auger bore or pipe ramming method. Additionally, although this work will take place during August and September when the creek is cry, steel plates or dunnage will be placed over the creek bed as temporary bridging material to minimize the potential for disturbing the creek bed and banks.

v. All work shall be consistent with applicable City of Bellevue codes and standards;

The proposed project will meet all applicable City of Bellevue codes and standards for a utility maintenance project, including obtaining all required permits and providing all supporting documentation, when requested by the City, for these permits.

vi. The facility or system shall not have a significant adverse impact on overall aquatic area flow peaks, duration or volume or flood storage capacity, or hydroperiod;

The project meets this performance standard. This project does not add impervious surface, nor does it change drainage patterns. There is no increase in stormwater volumes, peak flows, or durations. All excavation and trenching work will be conducted only during dry summer months (August and September) when the ephemeral creek is dry and when rainfall is not an issue. Temporary erosion and sedimentation control (TESC) measures will be implemented to minimize the potential for soil erosion. Construction be within the dry season, limiting the potential for rainwater to cause erosion. Silt fencing will be installed above the OHWM on both banks of the creek to prevent the potential for sediment laden water reaching the creek bed. Soil stockpiles will be covered with plastic tarping. Biodegradable wattles will be installed within the areas of soil disturbance to limit the speed of rainwater runoff and left to biodegrade over time. The disturbed soils will be revegetated.

vii. Associated parking and other support functions, including, for example, mechanical equipment and maintenance sheds, must be located outside critical area or critical area buffer except where no feasible alternative exists; and

The project meets this performance standard. When possible, equipment and materials will be stored outside of critical areas and critical area buffers. However, the majority of this water main replacement will be within the stream buffer and steep slope areas, because no feasible alternative exists to replace this water main.

viii. Areas of new permanent disturbance and all areas of temporary disturbance shall be mitigated and/or restored pursuant to a mitigation and restoration plan meeting the requirements of LUC 20.25H.210.

The project meets this performance standard. All areas of permanent disturbance (only tree removal) and all areas of temporary disturbance (trenching, bore pits, construction access, pipeline route) will be mitigated and restored pursuant to the Restoration and Planting Plan described below and presented in Attachment B.

20.25H.125 Performance standards – Landslide hazards and steep slopes.

In addition to generally applicable performance standards set forth in LUC 20.25H.055 and 20.25H.065, development within a landslide hazard or steep slope critical area or the critical area buffers of such hazards shall incorporate the following additional performance standards in design of the development, as applicable. The requirement for long-term slope stability shall exclude designs that require regular and periodic maintenance to maintain their level of function.

A. Structures and improvements shall minimize alterations to the natural contour of the slope, and foundations shall be tiered where possible to conform to existing topography;

The project meets this performance standard. The replacement water main will be contained entirely underground with all disturbed areas returned to the same existing contour of slope, avoiding any permanent alteration of the slope. Disturbed areas will be restored using native soil, hydroseeding, jute fabric matting and native shrubs planted into the matting.

B. Structures and improvements shall be located to preserve the most critical portion of the site and its natural landforms and vegetation;

The project meets this performance standard. The replacement water main will be contained entirely underground with all disturbed areas returned to the same existing contour of slope, avoiding any permanent alteration of the slope. Disturbed areas will be restored using native soil, hydroseeding, jute fabric matting and native shrubs planted into the matting.

C. The proposed development shall not result in greater risk or a need for increased buffers on neighboring properties;

The project meets this performance standard. As stated in Section 3.2 of the Geotechnical Report (Shannon and Wilson 2019), the proposed development will not result in greater risk or a need for increased buffers on neighboring properties.

D. The use of retaining walls that allow the maintenance of existing natural slope area is preferred over graded artificial slopes where graded slopes would result in increased disturbance as compared to use of retaining wall;

Not applicable. No site grading will be performed.

E. Development shall be designed to minimize impervious surfaces within the critical area and critical area buffer;

The project meets this performance standard. No permanent impervious surfaces will be created. All disturbed areas, including those within stream buffers and on steep slopes, will be restored the existing pervious (native soil and native plant) surface. The site will be prepared for restoration after construction by

removing quarry spalls placed in the temporary construction access areas, restoring those areas to existing pre-construction conditions, and seeding with native erosion control seed mix (Attachment B).

F. Where change in grade outside the building footprint is necessary, the site retention system should be stepped, and regrading should be designed to minimize topographic modification. On slopes in excess of 40 percent, grading for yard area may be disallowed where inconsistent with this criterion;

The project meets this performance standard. No change in grade is proposed in any location within the project alignment.

G. Building foundation walls shall be utilized as retaining walls rather than rockeries or retaining structures built separately and away from the building wherever feasible. Freestanding retaining devices are only permitted when they cannot be designed as structural elements of the building foundation;

Not applicable. This project has no above ground structures or buildings.

H. On slopes in excess of 40 percent, use of pole-type construction which conforms to the existing topography is required where feasible. If pole-type construction is not technically feasible, the structure must be tiered to conform to the existing topography and to minimize topographic modification;

Not applicable. This project does not include structures.

I. On slopes in excess of 40 percent, piled deck support structures are required where technically feasible for parking or garages over fill-based construction types; and

Not applicable. This project does not include structures.

J. Areas of new permanent disturbance and all areas of temporary disturbance shall be mitigated and/or restored pursuant to a mitigation and restoration plan meeting the requirements of LUC 20.25H.210. (Ord. 5680, 6-26-06, § 3)

The project meets this performance standard. Impacted portions of the stream buffer and steep slopes within the temporary construction limits will be restored through backfill of native soils, hydroseeding, and planting with native vegetation (See Attachment B). The mitigation plan, described below, includes several distinct elements: permanent impacts from tree removal, temporary construction impacts on steep slopes, and temporary construction impacts within the stream buffer. Tree removal within critical areas is the only permanent impact on the project. A total of 19 trees will be removed, 15 of which are significant trees. Significant trees will be replaced at a 3:1 ratio, with 50% Douglas Fir and 50% Western Red Cedar, or as directed by an arborist. Placement of the replacement trees will be at the direction and discretion of an arborist, but will be outside of the project alignment, to avoid future impacts of roots imposing on the new water main.

And also:

20.25H.135 Mitigation and monitoring – Additional provisions for landslide hazards and steep slopes.

In addition to the general mitigation and restoration plan requirements of LUC 20.25H.210, each mitigation or restoration plan for geologic hazard critical areas shall include:

A. Erosion and Sediment Control Plan.

Reference: **Critical Areas Land Use Permit Application for the Forest Hills Water Main Rehabilitation Project**

The erosion and sediment control plan shall be prepared in compliance with requirements set forth in Chapter 23.76 BCC, now or as hereafter amended. Such plans shall also include, if not otherwise addressed in Chapter 23.76 BCC, the location and methods of drainage, surface water management, locations and methods of erosion control, a vegetation management and/or replanting plan, and/or other means for maintaining long-term soil stability;

A TESC Plan and a Restoration and Planting Plan (Attachment B) have been prepared for the proposed project.

B. Drainage Plan.

The technical information shall include a drainage plan for the collection, transport, treatment, discharge, and/or recycle of water prepared in accordance with applicable City codes and standards. The drainage plan should consider on-site septic system disposal volumes where the additional volume will affect the erosion or landslide hazard area;

A drainage plan was not prepared because this project does not include the collection, transport, treatment, discharge and/or recycle of water. Additionally, in order to disturb as little ground surface as possible, no temporary storm water conveyance channels will be constructed. Biodegradable wattles, temporary hydroseeding in conjunction with jute erosion control netting will be utilized to minimize sediment runoff.

C. Monitoring Surface Waters.

If the Director determines that there is a significant risk of damage to downstream receiving waters due to potential erosion from the site, based on the size of the project, the proximity to the receiving waters, or the sensitivity of the receiving waters, the technical information shall include a plan to monitor the surface water discharge from the site. (Ord. 5680, 6-26-06, § 3)

All elements of the proposed project will take place when the ephemeral stream is dry (during August and September) and the best management practices (BMPs) described in the Construction Stormwater Pollution Prevention Plan (CSWPPP) will be implemented to prevent and reduce impacts to the dry stream channel downgradient of the slope and during dewatering of bore pits.

MITIGATION AND RESTORATION PLAN

The City is proposing restoration measures to compensate for the temporary impacts to the stream buffer area and the steep slope critical areas within the temporary construction limits of the Forest Hills Reservoir property (Parcel Number 2224059034) and the Forest Hills Open Space (Parcel Number 2597450870). The Restoration and Planting Plan (Attachment B) is designed to stabilize slopes and stream buffer areas to prevent erosion into the stream, and to replace the native plant assemblage removed within the temporarily impacted project area.

Impacted portions of the stream buffer and steep slopes within the temporary construction limits will be restored. The mitigation plan includes several distinct elements: permanent impacts from tree removal, temporary construction impacts on steep slopes, and temporary construction impacts within the stream buffer.

Tree removal within critical areas is the only permanent impact on the project. A total of 19 trees will be removed, 15 of which are significant trees. Significant trees to be replaced at a 3:1 ratio, with 50% Douglas Fir and 50% Western Red Cedar, or as directed by an arborist. Placement of the replacement trees will be at the

Reference: **Critical Areas Land Use Permit Application for the Forest Hills Water Main Rehabilitation Project**

direction and discretion of an arborist, but will be outside of the project alignment, to avoid future impacts of roots imposing on the new water main.

The site will be prepared for restoration after construction by removing quarry spalls and performing necessary regrading, as well as soil preparation. Detention ponds located along the construction access path in the Forest Hills Reservoir property will be cleared of all vegetation (currently covered with invasive English Ivy), restored to existing pre-construction conditions, and seeded with native erosion control seed mix.

Temporarily disturbed areas will be rototilled where possible to loosen compacted soils and improve plant survival, and then hydroseeded with mulching and tackifier and covered with jute erosion control blankets (or equivalent product) to stabilize slopes post-construction within the Forest Park Open Space. Hydroseeding will involve two seed mixes: a native riparian mix for the impacted stream buffer area, and native erosion control seed mix for steep slopes. Native shrubs will be installed through the erosion control blankets, per the landscaping plans and planting schedule, with an adaptive management strategy, allowing for minor adjustments and substitutions based on plant species availability. Additional mulching or landscape bark will be applied around planted shrubs and trees.

In addition, the water main installation will cross the established foot trail in three places. These sections of trail will be restored to pre-construction conditions. Pieces of large woody material (LWM) from the site may be retained and installed for stabilization of the foot trail on the downslope side. Additional LWM may be installed as extra wildlife habitat features, subject to the size, availability, and number of LWM, and would require a rearrangement of planting configurations on the site to accommodate.

Lastly, the temporary construction limits cross private property (parcel number 2600110590) on the steep slope. This private property area (lawn, landscaping, and ornamentation) will be restored and replaced in kind.

These mitigation and restoration measures will be implemented immediately following the completion of the construction. The landscaping plan and schedule are included in the attached Restoration and Planting Plan (Attachment B).

Kristi Rettmann

Kristi Rettmann M.Sc., CESCL
Environmental Scientist

Phone: 425.214.3901
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Attachment: Attachment A – Vicinity Map
Attachment B – Restoration and Planting Plan

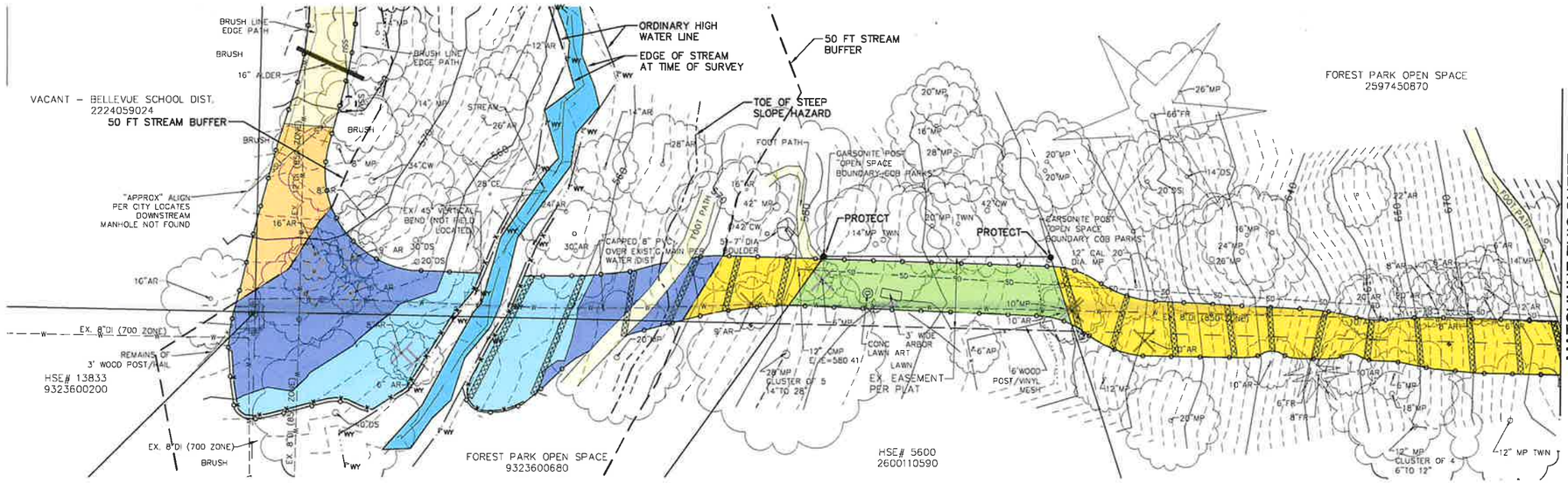
ATTACHMENT B

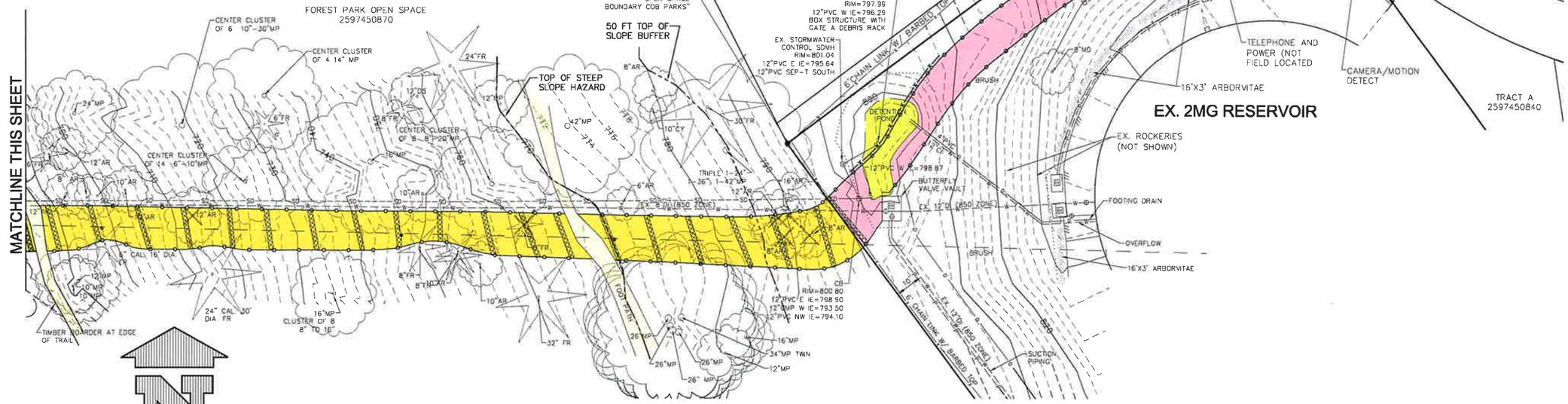
Restoration and Planting Plan

RESTORATION LEGEND

- CLEARING LIMITS
- SILT FENCING
- TREE TO BE REMOVED
- BIODEGRADABLE WATTLES (BMP C235)
- UPPER ACCESS - SPALLED (ZONE 1)
- MAIN SLOPE (ZONE 2)
- OUTER BUFFER (ZONE 3)
- INNER BUFFER (ZONE 4)
- WEST ACCESS - SPALLED (ZONE 5)
- STABILIZED CONSTRUCTION ACCESS (WOOD CHIPS)
- EXISTING FOOT TRAILS
- EXISTING STREAM
- EXISTING DETENTION POND
- PRIVATE PROPERTY

NOTE: SEE SHEET B8 FOR PLANTING SCHEDULE AND GENERAL RESTORATION NOTES.





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CALL BEFORE YOU DIG
1-800-424-5555 or 811
EXISTING UTILITIES SHOWN ARE FROM THE BEST AVAILABLE INFORMATION AND NO GUARANTEE IS MADE AS TO THE EXACT SIZE, TYPE, LOCATION OR DEPTH

N

20 0 20 40
SCALE IN FEET

PERMIT SUBMITTAL

NO.	DATE	BY	REVISIONS
B	3–21–19	TMT	PERMIT SUBMITTAL

Stantec
11130 NE 33rd Place, Bellevue WA 98004
phone: (425) 869-9448 www.stantec.com

TIMOTHY M TOBIN STATE OF WASHINGTON 47740 REGISTERED PROFESSIONAL ENGINEER 3/22/19

Approved By

DESIGN/CONSTRUCTION MANAGER	DATE
DESIGN SUPERVISOR	DATE
PROJECT MANAGER	DATE

TMT
DESIGNED BY DATE
TVW
DRAWN BY DATE
CHECKED BY DATE

City of Bellevue
UTILITIES

FOREST HILLS WATER MAIN REHABILITATION

RESTORATION AND PLANTING PLAN

NE 22-24-5 J15

SHT B8 OF 15

PLOTTING DATE: 3/22/2019 USER: Van Wechel, Terry VERSION: 2006 FILE NAME: V:\3002\active\302200367\civil\drawing\sheet\030679-RESTO PLAN.dwg

RESTORATION PLANTING SCHEDULE

Zone	Description	Total SF	Planting SF	Structural Community	Spp Name	Common Name	Community Comp	Plant Quantity[1]	Container	Spacing O.C. (ft)	Grouping	Planting Comments
1	Upper Access Spalled	2574	2254 (excludes detention pond areas)	Tree	Pseudotsuga menziesii	Douglas Fir	50	1	5 gallon or B&B	9	--	Planted outside the alignment at the discretion of arborist
				Tree	Thuja plicata	Western Red Cedar	50	2	5 gallon or B&B	9	--	Planted outside the alignment at the discretion of arborist
				Shrub	Gaultheria shallon	Salal	25	41	1 gallon	4	4-8	
				Shrub	Polystichum munitum	Western Sword Fern	25	41	1 gallon	4	4-8	
				Shrub	Mahonia nervosa	Low Oregon Grape	25	41	1 gallon	4	4-8	
				Shrub	Myrica californica	California Waxmyrtle	25	41	1 gallon	4	4-8	
2	Main Slope	8195	6948 (excludes foot trails and private property)	Tree	Pseudotsuga menziesii	Douglas Fir	50	14	5 gallon or B&B	9	--	Planted outside the alignment at the discretion of arborist
				Tree	Thuja plicata	Western Red Cedar	50	13	5 gallon or B&B	9	--	Planted outside the alignment at the discretion of arborist
				Shrub	Gaultheria shallon	Salal	40	200	1 gallon	4	4-8	
				Shrub	Polystichum munitum	Western Sword Fern	20	100	1 gallon	4	4-8	
				Shrub	Mahonia nervosa	Low Oregon Grape	40	200	1 gallon	4	4-8	
3	Outer Stream Buffer	2455	2297 (excludes foot trails)	Tree	Pseudotsuga menziesii	Douglas Fir	50	6	5 gallon or B&B	9	--	Planted outside the alignment at the discretion of arborist
				Tree	Thuja plicata	Western Red Cedar	50	6	5 gallon or B&B	9	--	Planted outside the alignment at the discretion of arborist
				Shrub	Gaultheria shallon	Salal	40	66	1 gallon	4	4-8	
				Shrub	Polystichum munitum	Western Sword Fern	20	33	1 gallon	4	4-8	
				Shrub	Mahonia nervosa	Low Oregon Grape	40	66	1 gallon	4	4-8	
4	Inner Stream Buffer	1861	1861	Tree	Pseudotsuga menziesii	Douglas Fir	50	1	5 gallon or B&B	9	--	Planted outside the alignment at the discretion of arborist
				Tree	Thuja plicata	Western Red Cedar	50	2	5 gallon or B&B	9	--	Planted outside the alignment at the discretion of arborist
				Tree	Rubus spectabilis	Salmonberry	50	67	1 gallon	4	4-8	
				Shrub	Cornus sericea	Red Twig Dogwood	25	34	1 gallon	4	4-8	
				Shrub	Oemleria cerasiformis	Indian Plum	25	34	1 gallon	4	4-8	
				Seed	Native Riparian Seed Mix	60% Blue Wildrye 30% Meadow Barley 10% California Brome	100	--	seed	--	--	1 lb. per 1000 sq ft (20 lbs. per acre), hydroseed with tackifier
5	West Access Spalled	793	793	Shrub	Gaultheria shallon	Salal	40	23	1 gallon	4	4-8	
				Shrub	Polystichum munitum	Western Sword Fern	20	11	1 gallon	4	4-8	
				Shrub	Mahonia nervosa	Low Oregon Grape	40	23	1 gallon	4	4-8	
All Disturbed Areas, except Zone 4, Inner Stream Buffer				Seed Mix	Native Erosion Control Mix	20% Mountain Brome 20% Slender Wheatgrass 20% Perennial Ryegrass 20% Annual Ryegrass 10% White Clover 10% Sterile Triticale Hybrid	100	--	seed	--	--	1 lb. per 1000 sq ft (20 lbs. per acre), hydroseed with tackifier, and then covered with jute blanket. Shrubs planted through holes in jute blanket.

1. Plant quantities calculated using triangular spacing arrangements.

GENERAL RESTORATION NOTES:

1. DETENTION PONDS SHALL BE CLEARED OF ALL VEGETATION (CURRENTLY COVERED WITH INVASIVE ENGLISH IVY). (ZONE 1)
2. DETENTION POND SLOPES SHALL BE RESTORED TO PRE-CONSTRUCTION CONDITIONS AND SEEDED WITH EROSION CONTROL SEED MIX.
3. FOOT TRAILS SHALL BE RESTORED TO EXISTING CONDITIONS.
4. CONTRACTOR SHALL UTILIZE TREES REMOVED ONSITE FOR DOWNSLOPE EDGE STABILIZATION ALONG RESTORED TRAIL LENGTHS (ZONES 2 AND 3). REMAINING REMOVED TREES MAY BE INSTALLED AS EXTRA WILDLIFE HABITAT FEATURES.
5. PRIVATE PROPERTY AREA (LAWN, LANDSCAPING, AND ORNAMENTATION) SHALL BE RESTORED AND REPLACED IN KIND. (ZONE 2)
6. QUARRY SPALLS SHALL BE COMPLETELY REMOVED AT THE COMPLETION OF PROJECT, AND AREA RESTORED TO PRE-CONSTRUCTION GRADES WITH ADDITIONAL TOPSOIL TO FILL TO EXISTING GRADE AND CONDITIONS FOR PLANTING.
7. WHERE POSSIBLE, DISTURBED AREAS SHALL BE ROTOTILLED TO A DEPTH OF 12" TO REDUCE SOIL COMPACTION AND IMPROVE PLANT SURVIVAL.
8. ALL DISTURBED AREAS, EXCEPT PATHS, SHALL BE HYDROSEEDED WITH MULCH AND TACKIFIER TO BIND SOIL (SEE PLANTING SCHEDULE). COVER HYDROSEEDED BARE SOILS AREAS (OVER TRENCH BACKFILL, ETC) WITH EROSION CONTROL BLANKETS (BMP C122). IF USING JUTE MATTING, ADDITIONAL MULCH APPLICATION IS REQUIRED. EXCELSIOR, WOVEN STRAW BLANKETS, AND COIR BLANKETS MAY BE INSTALLED WITHOUT MULCH.
9. PLANTS SHALL BE INSTALLED THROUGH THE EROSION CONTROL BLANKETS BY CUTTING AN "X" IN THE EROSION CONTROL BLANKETS, AND PLANTING WITHIN THE OPENING.
10. PROPOSED MITIGATION FOR TREE REMOVAL IS REPLACEMENT AT 3:1 RATIO, AS DIRECTED BY THE ARBORIST.

PERMIT SUBMITTAL

NO.	DATE	BY	REVISIONS
B	3-21-19	TMT	PERMIT SUBMITTAL

Stantec
11130 NE 33rd Place, Bellevue WA 98004
phone: (425) 869-9448 www.stantec.com

TIMOTHY M. TOBIN STATE OF WASHINGTON 47740 REGISTERED PROFESSIONAL ENGINEER 3/22/19

Approved By

DESIGN/CONSTRUCTION MANAGER	DATE
DESIGN SUPERVISOR	DATE
PROJECT MANAGER	DATE

TMT
DESIGNED BY DATE
TVW
DRAWN BY DATE
CHECKED BY DATE

City of Bellevue UTILITIES

FOREST HILLS WATER MAIN REHABILITATION
RESTORATION AND PLANTING SCHEDULE AND GENERAL NOTES

NE 22-24-5 J15 | SHT B9 OF 15

PLOTTING DATE: 3/22/2019 USER: Von Wechel, Terry VERSION: 2006 FILE NAME: V:\2003\active\200300679\civil\drawing sheet\030679-RESTO PLAN.dwg

SUBMITTED TO:
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BY:
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GEOTECHNICAL REPORT

Forest Hills Water Main Rehabilitation

BELLEVUE, WASHINGTON

SHANNON & WILSON

March 2019

Shannon & Wilson No: 102300-001

Submitted To: Stantec Consulting Services, Inc.
11130 NE 33rd Place, Suite 200
Bellevue, WA 98004
Attn: Mr. Tim Tobin

Subject: GEOTECHNICAL REPORT, FOREST HILLS WATER MAIN REHABILITATION, BELLEVUE, WASHINGTON

Shannon & Wilson prepared this report and participated in this project as a subconsultant to Stantec Consulting Services, Inc. Our scope of services was specified a in task order, dated January 17, 2019, to our Master Services Subconsultant Agreement, dated April 7, 2015. This report presents the results of geotechnical evaluation of the proposed construction of the water main on the steep slope and trenchless crossing under the ephemeral creek as part of the Forest Hills Water Main Rehabilitation Project and was prepared by the undersigned.

We appreciate the opportunity to be of service to you on this project. If you have questions concerning this report, or we may be of further service, please contact us.

Sincerely,

SHANNON & WILSON, INC.

3/21/19

David C. Ward, PE, LEG
Senior Associate

JCS:DCW:MSK/jcs

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1 INTRODUCTION

1.1 Overview

This geotechnical report summarizes our geotechnical studies for the Forest Hills Water Main Rehabilitation Project (Project) in Bellevue, Washington. (Figure 1). The purpose of our geotechnical studies was to evaluate the geotechnical feasibility and risks associated with construction of a water main on the steep slope and a trenchless crossing for the creek.

1.2 Background

The City of Bellevue Utilities Department plans to replace the existing 12-inch ductile iron (DI) water main (approximately 700 linear feet [LF]) between the City's Forest Hills Reservoir and the existing pressure reducing valve (PRV) station #100959, within the Forest Park Open Space (owned by the Bellevue Utilities Department). Recent testing reveals that the existing DI water main is failing prematurely, due to corrosion, with an expected remaining service life of only one to two years. To prevent the potential for a catastrophic break, replacement of this pipe has been added to the Capital Improvement Project for replacement in calendar year 2019. The locations of the existing and proposed water mains are shown in Figure 2.

Except for where the water main crosses under the ephemeral creek, most of the approximately 700 LF of replacement pipe will be installed using open cut excavation methods. We understand that the plan for the creek crossing is to use jack and bore or pipe ramming methods to install a steel casing a minimum of 6 feet below the creek bed. The replacement water main would be installed within the new permanent steel casing. The launching and receiving bore pits would be located within the stream buffer close to the stream.

Geotechnical recommendations related to the relocation of the PRV station to 140th Place SE are not included in this report.

1.3 Purpose and Scope of Services

We understand this geotechnical report will be used to advance the design of the proposed elements discussed in this report. This report should not be used for other purposes without Shannon & Wilson's review. Our scope of geotechnical services included:

- Drilling and sampling five borings.
- Water content determinations and three grain size analyses on samples obtained from the borings.

The grain size analyses in our scope were included to assist in evaluating potential dewatering requirements and to characterize the native soils for potential reuse. Based on the groundwater conditions observed in the borings and our review of samples, we determined that the grain size analyses were not required to complete our evaluation.

1.4 Investigations Summary

Shannon & Wilson completed a geotechnical investigation program which included four geotechnical borings to characterize the subsurface conditions present at selected locations along the proposed water main alignment. A fifth boring, scheduled for completion on March 25, 2019, is planned at the proposed PRV station. Field tests included performing Standard Penetration Tests (SPTs) in all the borings. Holt Services, Inc. (Holt) and CN Drilling, Inc. (CN) performed the borings under subcontract to Shannon & Wilson. The approximate locations of the borings are shown in Figure 2.

Holt drilled borings FH-1 and FH-4 on February 25, 2019, using a track-mounted drill rig (LDS-75). The LDS-75 used a continuous-flight auger with a hollow stem to advance the boring. This method uses applied down pressure and rotation at the top of the continuous-flight auger. Samples were obtained by lowering a split-spoon sampler through the hollow stem of the auger.

CN drilled borings FH-1 and FH-2 on February 18, 2019, using a hand operated, portable Acker Soil Mechanic (Acker) drill rig. The Acker uses a continuous-flight auger with a 2.25-inch-diameter hollow stem to advance the boring. This method uses applied down-pressure and rotation to the top of the continuous-flight auger. Samples were obtained by lowering a split-spoon sampler through the hollow stem of the auger.

Samples were obtained in conjunction with SPTs. The SPTs were performed in accordance with the ASTM Designation: D1586-18, Test Method for Penetration Test (SPT) and Split-Barrel Sampling of Soils (ASTM, 2018). The Standard Penetration Resistance (N-value) is recorded on the boring logs in Appendix A. The SPT N-value is a useful parameter for determining the relative density or consistency of the soils. Density or consistency as it is related to the SPT N value is shown in Figure A-1 in Appendix A.

After each split-spoon sampler was removed from the borehole, a Shannon & Wilson field representative opened the sampler and visually examined the sample. The field representative then described and classified the sample, removed it from the split-spoon

sampler, and sealed the sample in a jar. The jars were stored in boxes and returned to the Shannon & Wilson laboratory for further review.

Holt and CN backfilled the borings with bentonite chips and spread the drill cuttings on site.

2 SITE CONDITIONS

2.1 Location and Surface Conditions

The project site is in Bellevue, Washington. Most of the project is located in the Forest Park Open Space, Tax Parcel 2597450870, situated South of Highland Drive and West of 142nd Ave SE. The proposed water main alignment runs from the water storage tank located on Parcel 2224059034 off of 142nd Ave SE and extends westward down a steep forested slope varying from about 20 to 60 percent and crosses under the northernmost area of 5600 140th Pl SE to the bottom of the hill. The Forest Park Open Space is heavily forested, with multiple footpaths traversing across the slope. It is centered in a residential neighborhood consisting of single-family homes on primarily 1/4-acre to 1/3-acre lots. An ephemeral stream runs through the western edge of the site, running north to south, paralleling a utility access road to the west. A steep slope starting near the eastern stream bank rises sharply up to 142nd Ave SE.

The vertical datum for this Project is National Geodetic Vertical Datum of 1988 (NAVD 88).

2.2 Geologic Setting

The Project is located in the central Puget Sound Lowland, an elongated topographic and structural depression filled with a complex sequence of glacial and nonglacial sediments that overlie bedrock. The area has been glaciated six or more times in the past 2 million years. The distribution of sediments is complex because each glacial advance deposited new sediments and partially eroded previous sediments. Between glacial episodes, the complete or partial erosion or the reworking of deposits, as well as the local deposition of other sediments, took place. During the Vashon Stade of the Fraser Glaciation, about 15,000 to 13,000 years before present, the lobe of the Cordilleran Ice Sheet that covered the Puget Lowland was locally over 3,000 feet thick. When the glacial ice sheet receded from the area about 13,500 years ago, it left behind topography characterized by low-rolling relief about 500 feet above sea level with some deeply cut ravines and broad valleys. Since then, present-day geologic processes, such as erosion and deposition by streams and landsliding as well as human activity, have modified the ground surface and further complicated the geology.

Tectonically, the Puget Lowland is located in the forearc of the Cascadia Subduction Zone. The tectonics and seismicity of the region are the result of the relative northeastward subduction of the Juan de Fuca Plate beneath the North American Plate. North-south compression is accommodated beneath the Puget Lowland by a series of west- and northwest-trending faults that extend to depths of about 12 miles. The nearest active faults to the Project are termed the Seattle Fault Zone, which consists of a series of four or more east-west-trending, south-dipping fault splays beneath Seattle. Based on U.S. Geological Survey maps, the Project site lies within the boundaries of the Seattle Fault Zone with the nearest strands of the fault zone located less than 1.5 miles to the north and south of the Project site. Geologic evidence discovered in the 1990s indicates that ground surface rupture from the movement on this fault zone occurred as recently as 1,100 years before present.

2.3 Subsurface Conditions

The investigations were performed to evaluate geotechnical conditions at the site for the water main. Our observations are specific to the location and depth noted on the log and may not be applicable to all areas of the site. No amount of explorations or testing can precisely predict the characteristics, quality, or distribution of subsurface and site conditions. Potential variation includes, but is not limited to:

- The conditions between and below explorations may be different.
- The passage of time or intervening causes (natural and manmade) may result in changes to site and subsurface conditions.
- Groundwater levels and flow directions may fluctuate due to seasonal or recharge source variations.
- Groundwater flow between different aquifers can occur. No soil or rock layer should be assumed to be continuous and/or watertight.

If conditions different from those described herein are encountered during the construction phase, we should review our description of the subsurface conditions and reconsider our conclusions and recommendations.

Boring FH-1, drilled at the top of slope at the water storage tank location, encountered 14.5 feet of fill, likely placed during construction of the tank. The fill is loose to medium dense silt with gravel. Dense to very dense weathered siltstone was encountered 14.5 feet below ground surface.

Boring FH-2, drilled to a depth of 8.5 and located on the slope, encountered weathered siltstone about 4 feet below ground surface. The soil above 4 feet consisted of Silt with sand and sandy Silt, which is likely fill associated with trail construction and colluvium.

Borings FH-3 and FH-4 were drilled near the bottom of the slope on the east and west bank of the creek, respectively. Boring FH-4 encountered glacial till and till-like soils from ground surface to the bottom of the boring at 20.5 feet below ground surface. The glacial till and till-like soils are comprised of very dense, silty sand with gravel. Boring FH-3, on the east side of the creek, was drilled on the trail and encountered 2 feet of silt with gravel, which is likely fill associated with trail construction. Alluvial soils, consisting of silty gravel with sand was encountered between 2 and 8 feet below ground surface. Glacial till, consisting of very dense, silty sand material, was encountered at about 8 feet below ground surface.

2.4 Groundwater Conditions

Groundwater was not encountered at the site apart from an approximately 3.5-foot-thick perched layer in FH-3. The subsurface soils are generally dense to very dense and exhibit traits consistent with a low permeability classification. In relatively flat areas at the site, particularly along the access road, with observed water ponded at the surface that appears unable to permeate into the ground. The magnitude of seasonal groundwater fluctuation is not known.

3 DISCUSSION AND CONCLUSIONS

3.1 Mapped Hazard Areas

The Project area lies within two City of Bellevue hazard areas. These include Steep Slope and Very Severe Erosion Hazard areas. The limits of the mapped Steep Slope Hazard are shown in Figure 3. Based on our interpretation of the maps, our understanding of the designation of steep slopes, and our reconnaissance at the site, we recommend the elevations of the top and toe of the Steep Slope Hazard be defined as 770 and 567 feet, respectively. We understand that the critical area buffer for the Steep Slope Hazard area extend a distance of 50 feet from the top of the slope. The entire project alignment is located in a Very Severe Erosion Hazard area..

3.2 Slope Stability

Based on the width and depth of excavation, anticipated subsurface conditions, and conditions at the site, it is our opinion that the construction on the slope will not increase the risk of slope instability if vegetation is re-established, surface water is diverted from the alignment, and trench backfill is designed to limit the potential of groundwater accumulating in the slope. There are no known or documented deep-seated landslides in the Project area. During our site reconnaissance, we did not observe evidence of surficial

instability. We do note, that shallow, surficial sliding or accelerated creep associated with weathering of the underlying bedrock may occur in wet conditions.

Based on our review of the site, information from the borings performed, and assuming the recommendations included in this report are implemented, in our opinion, the proposed development will not result in greater risk or a need for increased buffers on neighboring properties.

3.3 Seismic Considerations

Due to the high relative density of the soil encountered and the limited amount of groundwater encountered, liquefaction is a low risk at the site. Localized, shallow landslides may occur during or after a seismic event, but anticipated seismic design accelerations are not anticipated to adversely affect the overall global stability of the slope. A seismic event could cause partial or complete damming of the ephemeral stream. Any flooding that would occur as a result of this scenario would occur at the toe of the slope, and would not adversely affect the stability of the slope.

3.4 Site Work

Because of the steepness of the slope, we recommend that the work be performed prior to the start of wet weather, which is typically defined as October 1. In addition, clearing and grubbing be limited to the smallest extent possible. Outside of the actual trench footprint, roots and stumps should be left undisturbed to help maintain the existing stability of the surficial soils. Grubbing should be limited to areas where roots and stumps are within or would interfere with the water main bedding and backfill. Finished grades should be established to route surface water away from the trench alignment. Permanent erosion and sediment control measures, likely consisting of staked jute netting, landscape bark, and selected revegetation, should be implement as soon as reasonably possible after backfilling is completed.

The Contractor should employ proper erosion control measures during construction. Covering work areas, soil stockpiles, or slopes with plastic, sandbags, sumps, and other measures should be employed as necessary to permit proper completion of the work. Barriers, such as bales of straw, geotextile silt fences, should be appropriately located and installed to control soil movement and erosion.

3.5 Dewatering Consideration

As discussed in Section 2.4, the geotechnical investigation data indicates the groundwater table is below the base of the proposed water main. However, up to 3.5 feet of perched

groundwater was encountered in boring FH-3. Consequently, during trench and/or pit excavation, perched groundwater may be encountered above the weathered siltstone and glacial till deposits and in sand seams within these layers. The contact between overlying saturated, coarse-grained soil and underlying low permeability materials tends to be irregular, so complete dewatering of perched groundwater is typically not be possible. Continued seepage into open excavations should be expected.

Discharge volumes from the perched groundwater is anticipated to be relatively low and we anticipate that groundwater control within the trench and/or pits could be handled with sumps and pumps. However, the receiving pit excavation for the trenchless crossing is closer to creek than boring FH-3, and groundwater conditions could vary. If sumps and pumps are not sufficient to control groundwater, then well points may be required. The use of relatively impermeable, interlocking steel sheets could also be used to reduce the dewatering requirements. Pre-drilling would likely be required to advance the steel sheets into the glacial till and till-like soils.

3.6 Excavation and Temporary Shoring

We recommend trench excavation depth be limited to balance reducing surface impacts and providing enough cover over the pipe to prevent damage to the pipe and limit pipe deflections. The shallower the excavation, the less impact the excavation will have on slope stability by reducing the amount of disturbance and the risk of introducing water into unwanted areas within the slope that might reduce stability. Based on Boring FH-2 and our reconnaissance of the site, we expected that if the pipe was installed at a depth of 5 feet it would be deep enough to be below the active creep layer on the slope.

We anticipate that relatively shallow trench excavations and excavations where disturbance and settlement of nearby utilities are not of concern could be accomplished using open trenches with temporary excavation slopes. Temporary shoring for the water main would be required to limit disturbance to the slope and provide worker protection and may be required to limit disturbance to adjacent utilities. The design of temporary shoring systems and excavation slopes and the method of construction should be the responsibility of the Contractor.

Based on the materials encountered in the borings, we anticipate all excavations could be made using excavating equipment such as rubber-tired backhoes or tracked hydraulic excavators. However, Contractor-selected specialized equipment or procedures will be required for excavation on steep slopes. For the water main, the trench width should be wide enough to allow for safe worker access and for satisfactory placement and compaction

of the bedding and backfill materials. The trench widths should also conform to pipe manufacturer's recommendations.

Temporary excavation slopes may be possible in the upper 5 feet of excavations if perched groundwater is adequately controlled, and where sufficient space is available to construct the slopes without impacting existing utilities, slopes, or trees. For safe working conditions and prevention of ground loss, excavation slopes and/or shoring should be the responsibility of the Contractor, because the Contractor will be at the site to observe and control the work. All current and applicable safety regulations regarding excavation slopes and shoring should be followed. For planning purposes, we recommend assuming a Contractor would construct sloped excavations no steeper than 1.5 Horizontal to 1 Vertical. Steeper slopes may be possible where bedrock is encountered. Flatter slopes may be required based on the actual conditions encountered, particularly where groundwater is encountered.

The excavation will encounter fill, glacial till and till-like soils, and weathered siltstone. The glacial till and till-like soils and the weathered siltstone in the subgrade are potentially moisture-sensitive and therefore easily disturbed and softened by construction equipment and operations. Consequently, we recommend that the last 2 feet of excavation be made using an excavating bucket equipped with a smooth, flat, steel plate over the digging teeth to reduce construction disturbance of the subgrade and, therefore, reduce post-construction settlements. In all cases, the Contractor should take steps to protect the subgrade from becoming disturbed after exposure.

3.7 Foundation Support

Based on the borings, we anticipate the water main will be primarily founded on weathered siltstone or glacial till. These materials are considered to be suitable foundation materials for the water main. There may be local areas where the pipe foundation is not suitable. In these areas, typical methods for overexcavation and replacement with geotextile wrapped imported fill or quarry spalls should be considered.

3.8 Trenchless Construction

Trenchless construction is being considered for use to construct a 34-foot long crossing with a minimum depth of 6 feet cover under the stream. Based on borings FH-3 and FH-4, we anticipate that the crossing would be constructed in glacial till and till-like soils. Groundwater is anticipated to be perched above the glacial till and till-like soils.

We evaluated two trenchless methods, auger boring and pipe ramming, that could be used. While the contract specifications should require the Contractor to select the trenchless method, in our opinion, auger boring would be the preferred method.

3.8.1 Trenchless Launching and Receiving Pits

We understand that because of the sloping ground surface at the site and the desired depth of the water main under the creek that the launching and receiving pits for the trenchless construction would be between about 14 to 20 feet deep. The glacial till and till-like soils encountered throughout boring FH-4 and below about 8 feet in boring FH-3 are generally well suited for shoring with stacked trench boxes or slide-rail shoring. These methods can also be used in fill and alluvium encountered above 8 feet in boring FH-3, however controlling the perched groundwater will be required. Methods for controlling groundwater are discussed in Section 3.4. To reduce the groundwater control requirements, a combination of steel sheets driven into the glacial-till and till-like soils and the use of a trench box below 8 feet could be considered. Pre-drilling may be required to advance the steel sheets into the glacial till and till-like soil. Monitoring of adjacent slopes and utilities during vibratory installation should be required.

We recommend that the temporary shoring be designed to resist a lateral earth pressure using an equivalent fluid weight of 36 pounds per cubic foot (pcf) if dewatering is used. The Contractor will need to determine the additional surcharge loading associated with their selected means and methods.

The available thrust reaction for auger boring can be calculated using an allowable passive pressure using an equivalent fluid weight of 210 pcf. This value was factored by 0.5 to limit the amount of deformation required to develop the passive pressure and provide thrust.

3.8.2 Auger Boring

Auger boring is a commonly used trenchless method on projects in glacial till and till-like deposits in the Puget Sound area. Auger boring typically uses an auger slightly smaller than the casing diameter to perform the excavation. As the pipe is jacked into the ground, the auger excavates the soil and carries it to the jacking pit for removal. An oversized cutting shoe is normally attached to the leading edge of the pipe string to stiffen the end of the pipe. The auger can be positioned in advance of the cutting shoe, flush with cutting shoe, or within the casing to facilitate construction and manage overexcavation. To avoid overexcavation such as can occur with the auger in advance of the cutting shoe, the auger can be withdrawn approximately one diameter inside the casing so that a soil plug forms at the entrance of the casing pipe. The soil plug will reduce the likelihood of soil flowing or running into the casing in saturated and unsaturated conditions, respectively. In dense soil,

the auger may need to be flush with or slightly ahead of the cutting shoe. Flowing or running ground, if encountered, could result in excessive ground loss.

The gravels encountered in borings near the site could likely be accommodated by the auger boring contractor. Cobbles and boulders, commonly present in glacial soils could be more problematic and, depending on the casing diameter could require a rescue pit to remove obstructions from in front of the leading edge of the casing.

3.8.3 Pipe Ramming

Pipe ramming is not as commonly used in glacial till and till-like soils. Pipe ramming typically utilizes a double-acting pneumatic hammer to drive an open-ended steel casing outward from the launching pit. Some or all of the soil can be left in the pipe during driving to limit ground loss and provide groundwater control. When possible, the soil is removed from the pipe after the drive is completed. With pipe ramming, the prediction of constructability is generally based more on previous jobs in similar ground than on engineering analyses or design. Pipe ramming is typically a non-steerable method.

The gravel encountered in borings near the site as well as cobbles and small boulders could likely be accommodated by the pipe ramming contractor. Large boulders could be more problematic and could require a rescue pit to remove obstruction from in front of the leading edge of the casing.

3.9 Backfill and Compaction

Where possible, we recommend that imported fill be used for the following reasons:

- The high fines content of the native soils.
- The difficulty in segregating, transporting, and storing the excavated soils.

3.9.1 Pipe Bedding

We recommend that the pipe bedding consist of imported granular bedding material meeting the gradational requirements specified in Section 9-03.12(3) of the Washington State Department of Transportation (WSDOT) Standard Specifications (WSDOT and American Public Works Association [APWA], 2018) or 5/8-inch minus crushed material. The bedding should extend a minimum of 4 inches below the bottom of the pipe and up to the pipe springline. The pipe bedding should be placed in a maximum loose backfill lift thickness of 6 inches and compacted to a 90% maximum dry density. The pipe bedding backfill should be carefully worked under the pipe by means of slicing with a shovel, vibration, tamping, or other approved method. Heavy mechanical compaction equipment should not be allowed within 2 feet of the pipes.

The reuse of native material as bedding carries inherent risks that may negatively impact the design life of the pipeline. Due to the high fines content of the native material anticipated at the site, proper compaction can be prohibitively difficult to achieve. Using an under-compacted pipe bedding material can lead to excessive settlement, stresses, or distortions of the pipeline and erosion of the trench backfill.

3.9.2 Trench Dams

Trench dams, also called trench plugs, should be installed to mitigate the flow of groundwater along the outside of the pipe and through the pipe bedding and backfill to reduce the potential for erosion and damage to the pipe bedding. We recommend that a trench dam be installed at the top elevation of each of the Steep Slope Hazard area defined in Section 3.1. In addition, we recommend that trench dams be located at a 30-foot spacing where the water main is within the identified Steep Slope Hazard area. While the native material may not be suitable for pipe bedding, if sufficient fine-grained native material is encountered, segregated and stockpiles, it could be reused to construct the trench dams. The weathered bedrock material may exhibit behavior when excavated that causes it to be excavated in "chunks" and would have to be processed into smaller pieces before being placed.

Alternatively, mixing small quantities of bentonite into native soil or using packaged, hydratable, powdered products that provide a similar function without requiring compaction could also be considered.

3.9.3 Trench Backfill

We recommend that the trench backfill, above the pipe bedding materials, meet the gradational requirements specified in Section 9-03.14(1) of the WSDOT Standard Specifications for Gravel Borrow. The backfill should be placed in uniform lifts and compacted to 90% of its Modified Proctor maximum dry density (ASTM Designation: D1557, Method C or D) (ASTM, 2012).

In areas where importing the recommended trench backfill material may not be feasible, particularly for the portions of pipeline excavation on a steep slope, native material that is free from wood waste, debris, clods or rocks greater than 6 inches in any dimension can be used for trench backfill as describe in Section 9-03.15 of the WSDOT Standard Specifications for Native Material for Gravel Borrow (WSDOT and APWA, 2018).

3.10 Pipe Anchorage

We understand that a combination of thrust blocks near the top and bottom of the slope and the use of restrained joints are intended to provide the required mitigation of longitudinal loading associated with flow and internal pressure. In addition, under-compacted trench backfill is more susceptible to movement on a slope, which could also impart longitudinal loading on the pipe. Because of the high fines content of the native material, it can be difficult to place and compact increasing the potential for additional loading due to backfill movement. Mid-slope pipe anchorage could help mitigate the effects of this loading on the long-term performance of the pipe if the restrained joints and thrust block at the top and bottom of the slope are not sufficient.

The mid-slope anchorage could consist of concrete thrust blocks. Grouted or mechanical ground anchors could be incorporated into the design of the thrust block to reduce the amount of concrete required.

3.11 Wet Weather Work

In the Project area, wet weather work generally begins about mid-October and continues through May, although rainy periods may occur at any time of year. It would be advisable to schedule the earthwork during the drier weather months; however, the following recommendations would apply if wet weather earthwork was unavoidable.

- The ground surface in the construction area should be sloped to promote rapid runoff of precipitation away from open excavation and to prevent ponding of water.
- Earthwork should be accomplished in small sections to minimize exposure to wet weather. That is, each section should be small enough so that the removal of unsuitable soils and placement and compaction of clean structural fill can be accomplished on the same day.
- Fill material to be placed should consist of clean, granular soil of which no more than 5 percent by dry weight passes the No. 200 sieve, based on wet sieving the fraction passing the ¾-inch sieve. The fines should be nonplastic.
- No soil should be left uncompacted and exposed to water. A smooth-drum vibratory roller, or equivalent, should roll the fill surface to seal out as much water as possible and promote rapid runoff of surface water.
- Soils that become too wet for compaction should be removed and replaced with clean, imported structural fill.
- Excavation and placement of structural fill should be observed on a full-time basis by a geotechnical engineer or engineer's representative experienced in earthwork to

determine that all work is being accomplished in accordance with the intent of the specifications.

- Grading and earthwork should not be accomplished during periods of heavy, continuous rainfall.

The above recommendations for wet weather earthwork should be incorporated into the contract specifications.

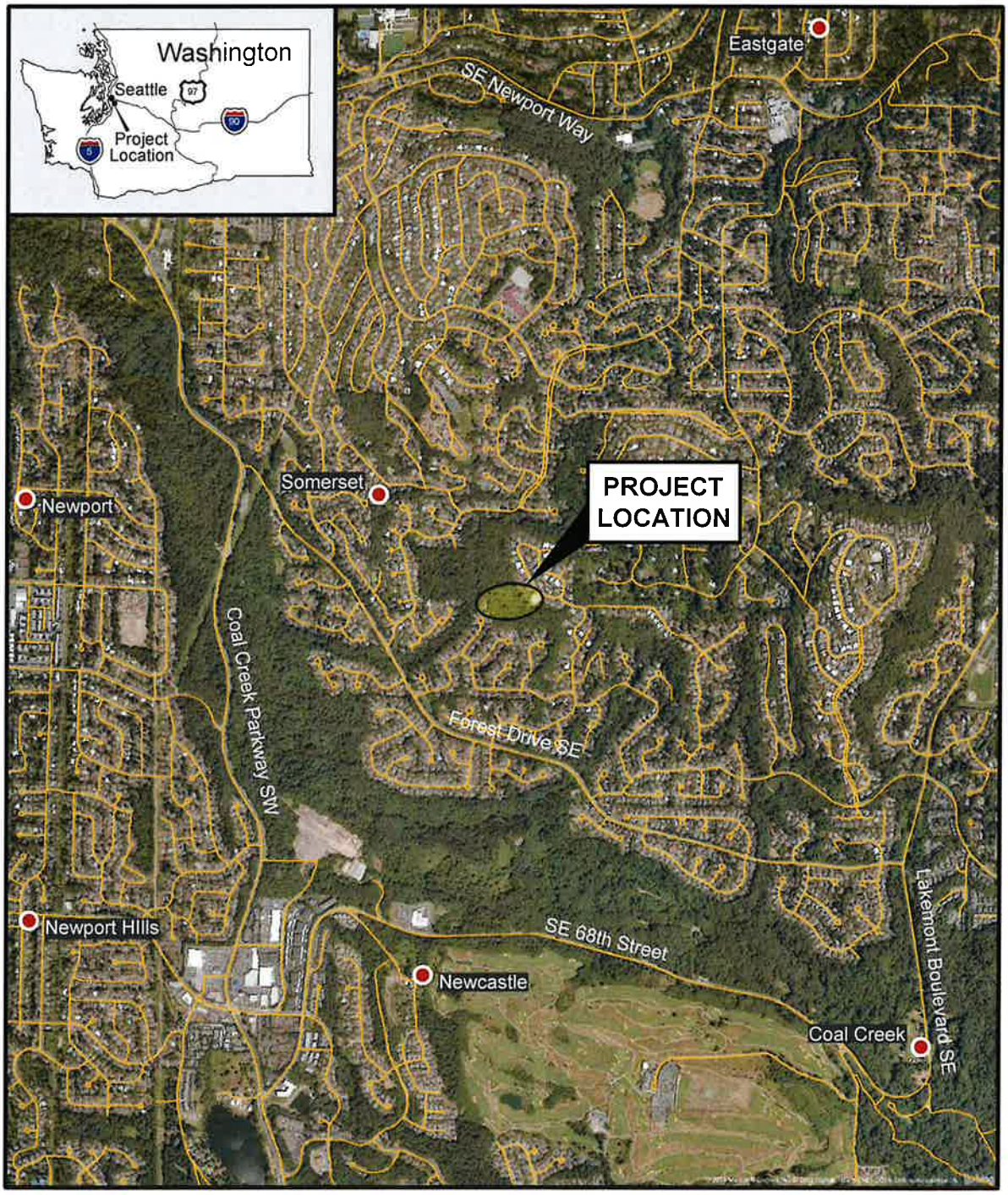
Shannon & Wilson, Inc. has prepared the enclosed "Important Information About Your Geotechnical/Environmental Report" to assist you and others in understanding the use and limitations of our reports.

4 REFERENCES

ASTM, 2012, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort, D1557-12e1, West Conshohocken, PA, ASTM International, Annual book of standards, 14 p., available: www.astm.org.

ASTM, 2018, Standard Test Method for Standard Penetration Test (SPT) and Split- Barrel Sampling of Soils, D1586-18, West Conshohocken, PA, ASTM International, Annual book of standards, 26 p., available: www.astm.org.

Washington State Department of Transportation (WSDOT) and American Public Works Association (APWA), 2018, Standard Specifications for Road, Bridge, and Municipal Construction, available: https://www.wsdot.wa.gov/Publications/Manuals/M41-10.htm



0 2,000 4,000

Approximate Scale in Feet

NOTE

Bing Map Image adapted from aerial imagery provided by Autodesk Live Maps and Microsoft Bing Maps reprinted with permission from Microsoft Corporation.

Forest Hills Water Main Rehabilitation
Bellevue, Washington

VICINITY MAP

March 2019 102300-001

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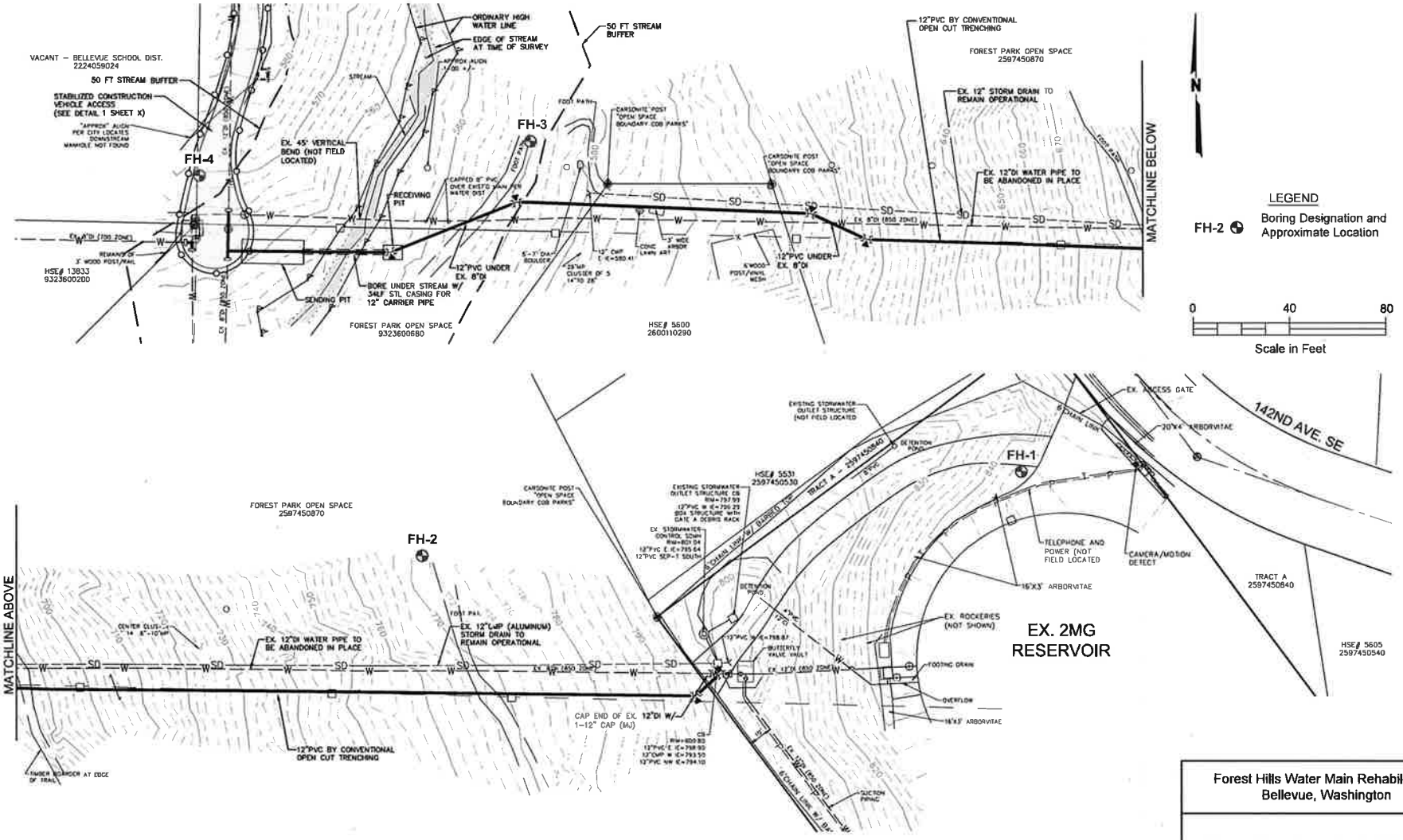
FIG. 1

Filename: J:_SEA\102300\001\102300-001 Vicinity Map.dwg Date: 03-11-2019 Login: jrs



NOTE

Figure adapted from file *03679-WATR PLAN.dwg*, *03679-WATR PDBASE.dwg*, and *03679c-et_c3d-17.dwg* received 03/08/2019.

Forest Hills Water Main Rehabilitation
Bellevue, Washington

SITE AND EXPLORATION PLAN

March 2019 102300-001

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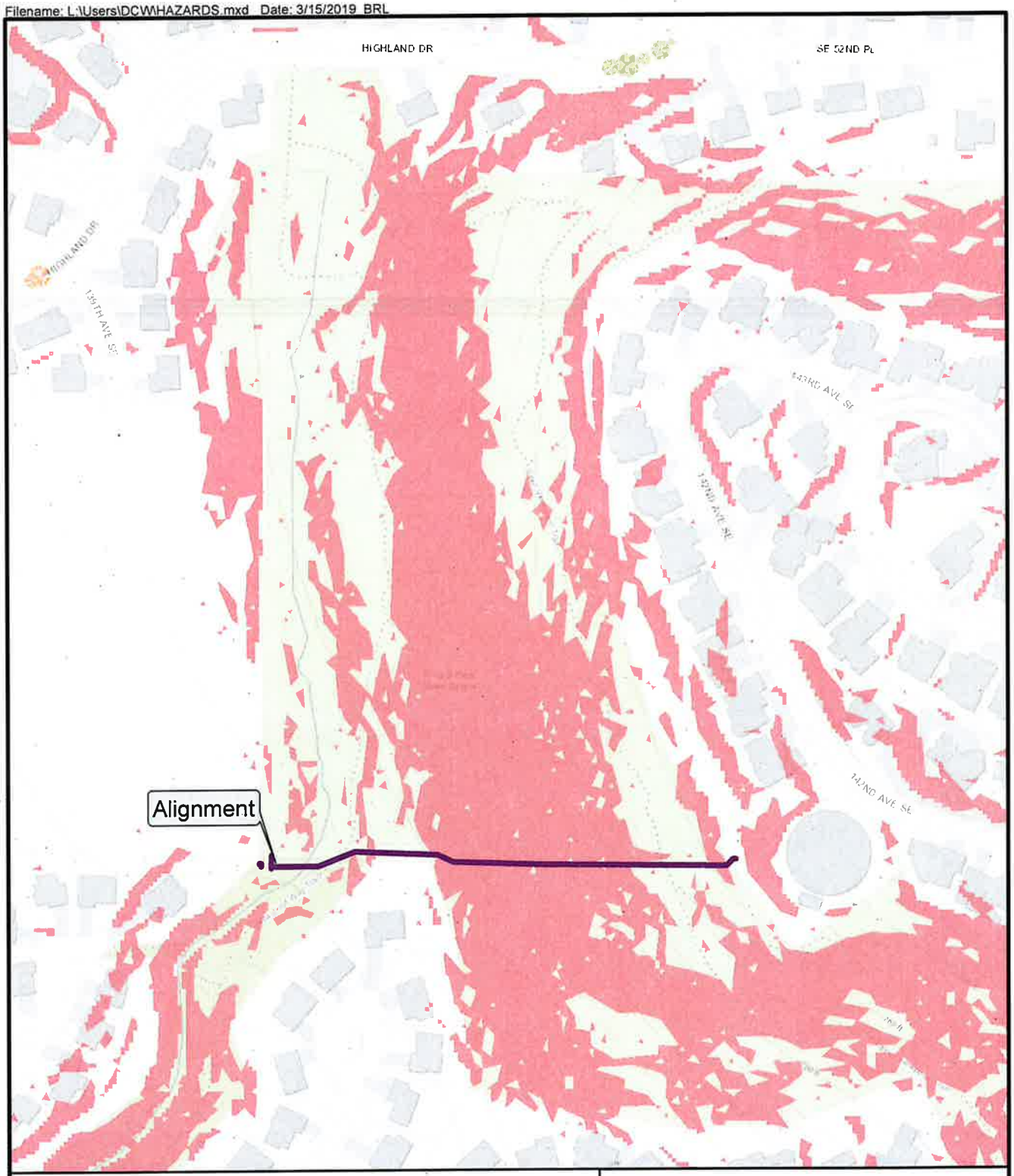
FIG. 2

Filename: \\sea-fs1\Drafting_SEA\102300\001\102300-001 Exploration.dwg Layout: Figure 2 Date: 03-18-2019 Login: jrb

Filename: L:\Users\DCW\HAZARDS.mxd Date: 3/15/2019 BRL



LEGEND

Steep Slopes (City of Bellevue)

NOTE: Map Area is within Very Severe Soil Erosion Hazard (City of Bellevue)

N
W E
S

0 200
Feet

Forest Hill Water Main Rehabilitation
Bellevue, Washington

HAZARD AREAS

March 2019 102300-001

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FIG. 3

APPENDIX A: SUBSURFACE INVESTIGATIONS

Appendix A

Subsurface Investigations

CONTENTS

Shannon & Wilson, Inc. (S&W), uses a soil identification system modified from the Unified Soil Classification System (USCS). Elements of the USCS and other definitions are provided on this and the following pages. Soil descriptions are based on visual-manual procedures (ASTM D2488) and laboratory testing procedures (ASTM D2487), if performed.

S&W INORGANIC SOIL CONSTITUENT DEFINITIONS

CONSTITUENT[2]	FINE-GRAINED SOILS (50% or more fines)[1]	COARSE-GRAINED SOILS (less than 50% fines)[1]
Major	***Silt, Lean Clay, Elastic Silt,*** or ***Fat Clay***[3]	***Sand*** or ***Gravel***[4]
Modifying (Secondary) Precedes major constituent	30% or more coarse-grained: ***Sandy*** or ***Gravelly***[4]	More than 12% fine-grained: ***Silty*** or ***Clayey***[3]
Minor Follows major constituent	15% to 30% coarse-grained: ***with Sand*** or ***with Gravel***[4]	5% to 12% fine-grained: ***with Silt*** or ***with Clay***[3]
	30% or more total coarse-grained *and* lesser coarse-grained constituent is 15% or more: ***with Sand*** or ***with Gravel***[5]	15% or more of a second coarse-grained constituent: ***with Sand*** or ***with Gravel***[5]

[1]All percentages are by weight of total specimen passing a 3-inch sieve.
[2]The order of terms is: *Modifying Major with Minor.*
[3]Determined based on behavior.
[4]Determined based on which constituent comprises a larger percentage.
[5]Whichever is the lesser constituent.

MOISTURE CONTENT TERMS

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, from below water table

STANDARD PENETRATION TEST (SPT) SPECIFICATIONS

Hammer:	140 pounds with a 30-inch free fall. Rope on 6- to 10-inch-diam. cathead 2-1/4 rope turns, > 100 rpm NOTE: If automatic hammers are used, blow counts shown on boring logs should be adjusted to account for efficiency of hammer.
Sampler:	10 to 30 inches long Shoe I.D. = 1.375 inches Barrel I.D. = 1.5 inches Barrel O.D. = 2 inches
N-Value:	Sum blow counts for second and third 6-inch increments. Refusal: 50 blows for 6 inches or less; 10 blows for 0 inches.

NOTE: Penetration resistances (N-values) shown on boring logs are as recorded in the field and have not been corrected for hammer efficiency, overburden, or other factors.

PARTICLE SIZE DEFINITIONS

DESCRIPTION	SIEVE NUMBER AND/OR APPROXIMATE SIZE
FINES	< #200 (0.075 mm = 0.003 in.)
SAND Fine Medium Coarse	 #200 to #40 (0.075 to 0.4 mm; 0.003 to 0.02 in.) #40 to #10 (0.4 to 2 mm; 0.02 to 0.08 in.) #10 to #4 (2 to 4.75 mm; 0.08 to 0.187 in.)
GRAVEL Fine Coarse	 #4 to 3/4 in. (4.75 to 19 mm; 0.187 to 0.75 in.) 3/4 to 3 in. (19 to 76 mm)
COBBLES	3 to 12 in. (76 to 305 mm)
BOULDERS	> 12 in. (305 mm)

RELATIVE DENSITY / CONSISTENCY

COHESIONLESS SOILS		COHESIVE SOILS	
N, SPT, BLOWS/FT.	RELATIVE DENSITY	N, SPT, BLOWS/FT.	RELATIVE CONSISTENCY
< 4	Very loose	< 2	Very soft
4 - 10	Loose	2 - 4	Soft
10 - 30	Medium dense	4 - 8	Medium stiff
30 - 50	Dense	8 - 15	Stiff
> 50	Very dense	15 - 30	Very stiff
		> 30	Hard

WELL AND BACKFILL SYMBOLS

Bentonite Cement Grout	Surface Cement Seal
Bentonite Grout	Asphalt or Cap
Bentonite Chips	Slough
Silica Sand	Inclinometer or Non-perforated Casing
Perforated or Screened Casing	Vibrating Wire Piezometer

PERCENTAGES TERMS [1, 2]

Trace	< 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

[1]Gravel, sand, and fines estimated by mass. Other constituents, such as organics, cobbles, and boulders, estimated by volume.

[2]Reprinted, with permission, from ASTM D2488 - 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

Forest Hills Water Main Rehabilitation
Bellevue, Washington

SOIL DESCRIPTION AND LOG KEY

March 2019 102300-001

SHANNON & WILSON, INC.
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FIG. A-1
Sheet 1 of 3

SOIL_CLASS_KEY_PG1 102300.GPJ SHAN_WIL.GDT 3/18/19

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)
(Modified From USACE Tech Memo 3-357, ASTM D2487, and ASTM D2488)

MAJOR DIVISIONS			GROUP/GRAPHIC SYMBOL		TYPICAL IDENTIFICATIONS
COARSE-GRAINED SOILS *(more than 50% retained on No. 200 sieve)*	Gravels *(more than 50% of coarse fraction retained on No. 4 sieve)*	Gravel *(less than 5% fines)*	GW		Well-Graded Gravel; Well-Graded Gravel with Sand
			GP		Poorly Graded Gravel; Poorly Graded Gravel with Sand
		Silty or Clayey Gravel *(more than 12% fines)*	GM		Silty Gravel; Silty Gravel with Sand
			GC		Clayey Gravel; Clayey Gravel with Sand
	Sands *(50% or more of coarse fraction passes the No. 4 sieve)*	Sand *(less than 5% fines)*	SW		Well-Graded Sand; Well-Graded Sand with Gravel
			SP		Poorly Graded Sand; Poorly Graded Sand with Gravel
		Silty or Clayey Sand *(more than 12% fines)*	SM		Silty Sand; Silty Sand with Gravel
			SC		Clayey Sand; Clayey Sand with Gravel
FINE-GRAINED SOILS *(50% or more passes the No. 200 sieve)*	Silts and Clays *(liquid limit less than 50)*	Inorganic	ML		Silt; Silt with Sand or Gravel; Sandy or Gravelly Silt
			CL		Lean Clay; Lean Clay with Sand or Gravel; Sandy or Gravelly Lean Clay
		Organic	OL		Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly Organic Silt or Clay
	Silts and Clays *(liquid limit 50 or more)*	Inorganic	MH		Elastic Silt; Elastic Silt with Sand or Gravel; Sandy or Gravelly Elastic Silt
			CH		Fat Clay; Fat Clay with Sand or Gravel; Sandy or Gravelly Fat Clay
		Organic	OH		Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly Organic Silt or Clay
HIGHLY-ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor		PT		Peat or other highly organic soils (see ASTM D4427)

NOTE: No. 4 size = 4.75 mm = 0.187 in.; No. 200 size = 0.075 mm = 0.003 in.

NOTES

1. Dual symbols *(symbols separated by a hyphen, i.e., SP-SM, Sand with Silt)* are used for soils with between 5% and 12% fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart. Graphics shown on the logs for these soil types are a combination of the two graphic symbols (e.g., SP and SM).

2. Borderline symbols *(symbols separated by a slash, i.e., CL/ML, Lean Clay to Silt; SP-SM/SM, Sand with Silt to Silty Sand)* indicate that the soil properties are close to the defining boundary between two groups.

Forest Hills Water Main Rehabilitation
Bellevue, Washington

SOIL DESCRIPTION AND LOG KEY

March 2019 102300-001

SHANNON & WILSON, INC.
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FIG. A-1
Sheet 2 of 3

SOIL_CLASS_KEY_PG2 102300.GPJ SHAN_WIL.GDT 3/18/19

GRADATION TERMS

Poorly Graded	Narrow range of grain sizes present or, within the range of grain sizes present, one or more sizes are missing (Gap Graded). Meets criteria in ASTM D2487, if tested.
Well-Graded	Full range and even distribution of grain sizes present. Meets criteria in ASTM D2487, if tested.

CEMENTATION TERMS[1]

Weak	Crumbles or breaks with handling or slight finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

PLASTICITY[2]

DESCRIPTION	VISUAL-MANUAL CRITERIA	APPROX. PLASITICITY INDEX RANGE
Nonplastic	A 1/8-in. thread cannot be rolled at any water content.	< 4
Low	A thread can barely be rolled and a lump cannot be formed when drier than the plastic limit.	4 to 10
Medium	A thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. A lump crumbles when drier than the plastic limit.	10 to 20
High	It takes considerable time rolling and kneading to reach the plastic limit. A thread can be rerolled several times after reaching the plastic limit. A lump can be formed without crumbling when drier than the plastic limit.	> 20

ADDITIONAL TERMS

Mottled	Irregular patches of different colors.
Bioturbated	Soil disturbance or mixing by plants or animals.
Diamict	Nonsorted sediment; sand and gravel in silt and/or clay matrix.
Cuttings	Material brought to surface by drilling.
Slough	Material that caved from sides of borehole.
Sheared	Disturbed texture, mix of strengths.

PARTICLE ANGULARITY AND SHAPE TERMS[1]

Angular	Sharp edges and unpolished planar surfaces.
Subangular	Similar to angular, but with rounded edges.
Subrounded	Nearly planar sides with well-rounded edges.
Rounded	Smoothly curved sides with no edges.
Flat	Width/thickness ratio > 3.
Elongated	Length/width ratio > 3.

[1]Reprinted, with permission, from ASTM D2488 - 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

[2]Adapted, with permission, from ASTM D2488 - 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

ACRONYMS AND ABBREVIATIONS

ATD	At Time of Drilling
Diam.	Diameter
Elev.	Elevation
ft.	Feet
FeO	Iron Oxide
gal.	Gallons
Horiz.	Horizontal
HSA	Hollow Stem Auger
I.D.	Inside Diameter
in.	Inches
lbs.	Pounds
MgO	Magnesium Oxide
mm	Millimeter
MnO	Manganese Oxide
NA	Not Applicable or Not Available
NP	Nonplastic
O.D.	Outside Diameter
OW	Observation Well
pcf	Pounds per Cubic Foot
PID	Photo-Ionization Detector
PMT	Pressuremeter Test
ppm	Parts per Million
psi	Pounds per Square Inch
PVC	Polyvinyl Chloride
rpm	Rotations per Minute
SPT	Standard Penetration Test
USCS	Unified Soil Classification System
q_u	Unconfined Compressive Strength
VWP	Vibrating Wire Piezometer
Vert.	Vertical
WOH	Weight of Hammer
WOR	Weight of Rods
Wt.	Weight

STRUCTURE TERMS[1]

Interbedded	Alternating layers of varying material or color with layers at least 1/4-inch thick; singular: bed.
Laminated	Alternating layers of varying material or color with layers less than 1/4-inch thick; singular: lamination.
Fissured	Breaks along definite planes or fractures with little resistance.
Slickensided	Fracture planes appear polished or glossy; sometimes striated.
Blocky	Cohesive soil that can be broken down into small angular lumps that resist further breakdown.
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay.
Homogeneous	Same color and appearance throughout.

Forest Hills Water Main Rehabilitation
Bellevue, Washington

SOIL DESCRIPTION AND LOG KEY

March 2019 102300-001

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FIG. A-1
Sheet 3 of 3

SOIL_CLASS_KEY_PG3 102300.GPJ SHAN_WIL.GDT 3/18/19

Total Depth:	21 ft.	Northing:	~	Drilling Method:	Hollow Stem Auger	Hole Diam.:	8 in.
Top Elevation:	~ 844 ft.	Easting:	~	Drilling Company:	Holt	Rod Diam.:	NWJ
Vert. Datum:	NAVD 88	Station:	~	Drill Rig Equipment:	Mobile B-57 Track Rig	Hammer Type:	Automatic
Horiz. Datum:	~	Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Depth, ft. | Symbol | Samples | Ground Water Depth, ft.

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*

0 | 20 | 40 | 60

Loose to medium dense, mottled brown and yellow-brown *Silt with Gravel (ML)*; moist; fine to coarse, subangular gravel; few fine to coarse sand; low plasticity; diamict.
(Hf)

7.0

Loose to dense, mottled brown and yellow-brown *Silt with Gravel (ML)* to *Silty Gravel with Sand (SM)*; moist; fine to coarse, subangular gravel; fine to coarse sand; low plasticity; diamict.
(Hf)

- Boulder from 10.5 to 12 feet.

14.5

None Observed During Drilling

5

10

CONTINUED NEXT SHEET

LEGEND

* Sample Not Recovered

I 2.0" O.D. Split Spoon Sample

◇ % Fines (<0.075mm)

● % Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

Forest Hills Water Main Rehabilitation
Bellevue, Washington

LOG OF BORING FH-1

March 2019 102300-001

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FIG. A-2
Sheet 1 of 2

REV 3 - Approved for Submittal

MASTER_LOG_E 102300.GPJ SHAN_WIL.GDT 3/21/19 Log: JJM Rev: EAS Typ: LKN

Total Depth:	21 ft.	Northing:	~	Drilling Method:	Hollow Stem Auger	Hole Diam.:	8 in.
Top Elevation:	~ 844 ft.	Easting:	~	Drilling Company:	Holt	Rod Diam.:	NWJ
Vert. Datum:	NAVD 88	Station:	~	Drill Rig Equipment:	Mobile B-57 Track Rig	Hammer Type:	Automatic
Horiz. Datum:	~	Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Depth, ft. | Symbol | Samples | Ground Water Depth, ft.

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches

0 20 40 60

Dense to very dense, mottled yellow-brown and red-brown, *Sandy Silt (ML)* to *Silty Sand (SM)*; moist; few fine to coarse, subangular gravel; fine to medium sand; nonplastic to low plasticity; few pockets of iron oxide staining; weathered siltstone.

6
7
8

76
74

20

21.0

BOTTOM OF BORING
COMPLETED 2/25/2019

25

0 20 40 60

LEGEND

* Sample Not Recovered

2.0" O.D. Split Spoon Sample

◇ % Fines (<0.075mm)

● % Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

Forest Hills Water Main Rehabilitation
Bellevue, Washington

LOG OF BORING FH-1

March 2019 102300-001

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FIG. A-2
Sheet 2 of 2

REV 3 - Approved for Submittal

MASTER_LOG_E_102300.GPJ SHAN_WIL.GDT 3/21/19 Log: JJM Rev: EAS Typ: LKN

Total Depth:	8.5 ft.	Northing:	~	Drilling Method:	Hollow Stem Auger	Hole Diam.:	4.5 in.
Top Elevation:	~ 772 ft.	Easting:	~	Drilling Company:	CN Drilling	Rod Diam.:	AW
Vert. Datum:	NAVD 88	Station:	~	Drill Rig Equipment:	Acker Soil Mechanic	Hammer Type:	Cathead
Horiz. Datum:	~	Offset:	~	Other Comments:			

SOIL DESCRIPTION	Depth, ft.	Symbol	Samples	Ground Water Depth, ft.	PENETRATION RESISTANCE (blows/foot)
Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.					▲ Hammer Wt. & Drop: 140 lbs / 30 inches
Loose, mottled brown and dark brown *Silt with Sand (ML)* to *Sandy Silt (ML)*; moist; trace to few fine, subrounded gravel; fine to coarse sand; nonplastic to low plasticity; few organics and roots. (Hf)			1 G	None Observed During Drilling	
			2		
Very dense, brown *Silt (ML)* to *Silt with Sand (ML)*; moist; fine sand; nonplastic to low plasticity; few fractures with iron oxide staining; weathered siltstone.	4.0		3		50/5.5"
			4		50/6"
BOTTOM OF BORING COMPLETED 2/18/2019	8.5				

0 20 40 60

5

10

0 20 40 60

◇ % Fines (<0.075mm)

● % Water Content

LEGEND

* Sample Not Recovered

G Grab Sample

2.0" O.D. Split Spoon Sample

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

Forest Hills Water Main Rehabilitation
Bellevue, Washington

LOG OF BORING FH-2

March 2019 102300-001

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FIG. A-3

REV 3 - Approved for Submittal

MASTER_LOG_E 102300.GPJ SHAN_WIL.GDT 3/21/19 Log: MXC Rev: JCS/EAS Typ: LKN

Total Depth:	10.4 ft.	Northing:	~	Drilling Method:	Hollow Stem Auger	Hole Diam.:	4.5 in.
Top Elevation:	~ 570 ft.	Easting:	~	Drilling Company:	CN Drilling	Rod Diam.:	AW
Vert. Datum:	NAVD 88	Station:	~	Drill Rig Equipment:	Acker Soil Mechanic	Hammer Type:	Cathead
Horiz. Datum:	~	Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Depth, ft. | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches

0 20 40 60

Dark brown *Silt with Gravel (ML)*; moist; subrounded, fine to coarse gravel; few fine to coarse sand; low plasticity; few organics.
(Hf)

2.0

Meidum dense to dense, *Silty Gravel with Sand (GM)*; wet; fine to coarse, subrounded gravel; fine to coarse sand; nonplastic to low plasticity fines.
(Ha)

- Layer of clayey gravel at 7.7 feet.

7.9

Very dense, gray, *Silty Sand (SM)* to *Sandy Silt (ML)*; moist; fine to medium sand; nonplastic.
(Qvt)

10.4

BOTTOM OF BORING
COMPLETED 2/18/2019

1 2 3 4 5

During Drilling ▽

5 10

50/5.5" 50/5.5"

0 20 40 60

LEGEND

* Sample Not Recovered
Grab Sample
2.0" O.D. Split Spoon Sample
▽ Ground Water Level ATD

◇ % Fines (<0.075mm)
● % Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

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Bellevue, Washington

LOG OF BORING FH-3

March 2019 102300-001

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FIG. A-4

REV 3 - Approved for Submittal

MASTER_LOG_E 102300.GPJ SHAN_WIL.GDT 3/21/19 Log: MXC Rev: JCS/EAS/yp: LKN

Total Depth:	20.5 ft.	Northing:	~	Drilling Method:	Hollow Stem Auger	Hole Diam.:	8 in.
Top Elevation:	~ 572 ft.	Easting:	~	Drilling Company:	Holt	Rod Diam.:	NWJ
Vert. Datum:	NAVD 88	Station:	~	Drill Rig Equipment:	Mobile B-57 Track Rig	Hammer Type:	Automatic
Horiz. Datum:	~	Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Depth, ft. | Symbol | Samples | Ground Water Depth, ft.

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*

0 20 40 60

Very dense, gray-brown, *Silty Sand (SM)*; moist; trace to few, fine to coarse, subangular gravel; fine to coarse sand; nonplastic; diamict.
(Qvt)

12.0

Very dense, gray, *Silty Sand (SM)*; moist; trace to few subrounded gravel; fine to medium sand; nonplastic; diamict pockets.
(Qvd)

Samples: 1, 2, 3, 4, 5

None Observed During Drilling

5

10

84

50/2.8"

50/4"

50/5.5"

50/2.5"

0 20 40 60

◇ % Fines (<0.075mm)

● % Water Content

CONTINUED NEXT SHEET

LEGEND

* Sample Not Recovered

I 2.0" O.D. Split Spoon Sample

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

Forest Hills Water Main Rehabilitation
Bellevue, Washington

LOG OF BORING FH-4

March 2019 102300-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-5
Sheet 1 of 2

REV 3 - Approved for Submittal

MASTER_LOG_E 102300.GPJ SHAN_WIL.GDT 3/21/19 Log: JJM Rev: EAS Typ: LKN

Total Depth:	20.5 ft.	Northing:	~	Drilling Method:	Hollow Stem Auger	Hole Diam.:	8 in.
Top Elevation:	~ 572 ft.	Easting:	~	Drilling Company:	Holt	Rod Diam.:	NWJ
Vert. Datum:	NAVD 88	Station:	~	Drill Rig Equipment:	Mobile B-57 Track Rig	Hammer Type:	Automatic
Horiz. Datum:	~	Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Depth, ft. | Symbol | Samples | Ground Water Depth, ft.

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches

0 20 40 60

Depth, ft.	Samples	Penetration Resistance (blows/foot)
	6	50/5.5"
	7	50/4"
20	8	50/5"
20.5		
25		

BOTTOM OF BORING
COMPLETED 2/25/2019

0 20 40 60

LEGEND

* Sample Not Recovered

2.0" O.D. Split Spoon Sample

◇ % Fines (<0.075mm)

● % Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

Forest Hills Water Main Rehabilitation
Bellevue, Washington

LOG OF BORING FH-4

March 2019 102300-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-5
Sheet 2 of 2

REV 3 - Approved for Submittal

MASTER_LOG_E_102300.GPJ SHAN_WIL.GDT 3/21/19 Log: JJM Rev: EAS Typ: LKN

IMPORTANT INFORMATION

Important Information

About Your Geotechnical/Environmental Report

IMPORTANT INFORMATION

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors that were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining

IMPORTANT INFORMATION

your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary, because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims

being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports, and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland